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RESEARCH ARTICLE – MEDICINE (MISCELLANEOUS

Evaluation of the Effect Variables on the Effectiveness of Physical Therapy for Patients with Knee Osteoarthritis Single-Blind Randomized Clinical Trial

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Abstract

Background: Knee osteoarthritis is a progressive joint condition characterized by cartilage degeneration, leading to pain, stiffness, and reduced mobility, especially among older adults. Its prevalence is rising due to aging populations and obesity. Primary or secondary OA can develop, with risk factors such as age, gender, and joint injuries playing significant roles. Physical therapy is a cornerstone in managing OA, targeting symptom relief and improved joint function.

Objective of study: The aim of a study assessing how demographic variables affect the efficacy of physical therapy for patients with osteoarthritis in the knee is probably to investigate the ways in which age, gender, socioeconomic status, body mass index (BMI).

Materials and Methods: This single-blind randomized clinical trial, approved by the Ethics Committee and registered in the Iranian Systematic physical treatment program for knee OA was evaluated by the Clinical Trials Registry. Twenty individuals between the ages of 40 and 65 who had grade II or III OA verified by radiographic and clinical standards were included. The 12-session regimen included strengthening exercises for the Knee, hip and trunk as well as heat therapy. The WOMAC assess the results, with an emphasis on physical function, stiffness, and discomfort.

Results: Age, MI, and pain reduction were found to be significantly correlated negatively in the study, suggesting that older people and those with greater BMIs experienced less improvement. On the other hand, there were no noteworthy correlations between treatment outcomes and gender, height, or weight. The study emphasizes how age and body mass index (BMI) impact the effectiveness of physical treatment.

Conclusion: Shows that demographic factors, especially age and BMI, have a major impact on how well physical therapy works for osteoarthritis in the knee. Especially for older persons and those with higher BMIs. Future studies should focus on creating individualized rehabilitation plans to enhance care for a variety of individuals.

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Keywords: Knee Osteoarthritis, WOMAC, Patient Disability, Demographic Characteristics, Physical Therapy

1. Introduction

Knee osteoarthritis, often referred to as degenerative joint disease, involves the gradual deterioration of the articular cartilage, predominantly linked to aging and mechanical stress. It commonly impacts older adults, manifesting as a chronic condition with a gradual escalation in symptoms over time. The disease's progression rate varies significantly among individuals, with symptoms ranging from mild discomfort to debilitating pain. Common clinical manifestations include increasing knee pain during physical activities, stiffness, joint swelling, and exacerbated discomfort after prolonged inactivity. As the disease advances, pain intensity and frequency tend to rise, often resulting in functional impairments and diminished quality of life, Epidemiological data reveal that knee osteoarthritis is the most prevalent form of arthritis worldwide, with its incidence rising due to increasing life expectancy and obesity rates. Among individuals over 60 years old, symptomatic knee osteoarthritis affects approximately 13% of women and 10% of men, with prevalence climbing to 40% in those aged 70 and older. Notably, the condition is more frequent in females, and radiographic evidence of knee osteoarthritis does not always correlate with symptoms—only 15% of individuals with radiographic findings report symptomatic issues. Annually, around 240 out of every 100,000 people experience symptomatic knee osteoarthritis [1].

This condition can be classified as primary or secondary, based on its underlying cause. Primary knee osteoarthritis is associated with the natural degeneration of cartilage without any specific etiology, often attributed to aging. In contrast, secondary knee osteoarthritis arises from identifiable factors such as trauma, surgical interventions, congenital deformities, or poor alignment of the lower limbs. These include post-

traumatic injuries, bowing or flexion deformities, scoliosis, and conditions like rickets [2, 3]. The risk factors for knee osteoarthritis are divided into modifiable and non-modifiable categories. Modifiable factors include joint injuries, occupational stress (e.g., prolonged standing or repetitive knee bending), muscle weakness or imbalances, obesity, and metabolic syndrome. Non-modifiable factors encompass age, gender (with a higher prevalence in females), genetic predisposition, and racial differences [1]. OA risk increases with age, particularly over 50, as aging affects chondrocyte function, reducing proteoglycan production and impairing cartilage maintenance. This leads to cartilage degeneration and OA. However, OA is not solely age-dependent, as joint degeneration varies across individuals and can occur independently of aging. These age-related physiological changes may influence both symptom severity and the effectiveness of interventions, underscoring the importance of considering age as a variable when interpreting Results [4].

Obesity increases OA risk through systemic and biomechanical pathways, with excess weight intensifying joint stress, especially in weight-bearing joints like the knees. Given that height and weight are important components of body mass index (BMI) that could otherwise skew study results, it is imperative that the groups exhibit no statistically significant variations in these variables for a valid comparison [5]. Physical therapy has an important role in controlling knee osteoarthritis (KOA), according to numerous scientific investigations looking into treatment options. Physical therapy has been repeatedly demonstrated to improve people's functioning capacities in addition to reducing pain. A more durable and less medication-dependent management approach results from the reduction of pain, which also frequently lessens the need for analgesic drugs [6, 7]. Osteoarthritis (OA) patients frequently experience increasing mobility problems and chronic pain, which drastically lowers their overall quality of life [8].

A key component of managing osteoarthritis (OA) is physical therapy (PT), which aims to maintain joint functionality, reduce discomfort, and assist with weight management [9-12]. Both German and international clinical guidelines promote physical therapy (PT) as the major technique for treating osteoarthritis (OA), providing a useful way to postpone surgical procedures when combined with patient education and pain-relieving drugs [8,13,14]. Despite these recommendations, insufficient adherence to OA treatment guidelines has contributed to the underutilization of PT services [15]. For instance, in Germany, only 49% of OA patients accessed PT in the year leading up to their surgery. This utilization rate was even lower in several other Western countries, including the United States, Australia, and Taiwan [16-18], there are many methods and mechanisms of physical therapy for patients with knee osteoarthritis. This study focuses on evaluating the relationship between the effectiveness of physical therapy and its relationship to the demographic variables of the study sample individuals.

2. Material and Methods

2.1. Study of the design

A single-blind randomized clinical trial was conducted following approval from the research ethics committee of the school of rehabilitation sciences, Iran university of medical sciences (Ethics Code: IR.IUMS.REC.1403.168). Participants were thoroughly informed about the study's objectives, procedures, and their rights, ensuring a clear understanding before providing written informed consent. To maintain ethical standards, participants were assured that no financial costs would be incurred for their participation. Confidentiality of all collected data was strictly protected through secure storage systems, accessible only to the principal investigator. Participants were assured of their right to exit the trial at any point without needing to give a reason, maintaining voluntary participation throughout. They signed a consent form to join the study. The trial was pre-registered with the Iranian Clinical Trials Registry (registration code; IRCT2015031421459N7), adhering to international standards for clinical trial transparency and ethical practices.

2.2. Participants

Following a confirmed diagnosis of knee osteoarthritis (KOA) based on clinical symptoms and radiographic imaging, participants of both sexes, ages 40 to 65, and were referred to the physiotherapy clinic at Sadr AI-Qanat Hospital in Baghdad. A radiologist used the Kellgren- Lawrence grading method to determine the degree of osteoarthritis in the knee. Inclusion criteria required that participants had chronic knee pain, either unilateral knee osteoarthritis, Exclusion criteria included patients with recent fractures, prolonged immobilization, other grades of knee osteoporosis (grade I and IV) and severe cardiopulmonary disease.

2.3. Intervention

To enhance stability, strength, and functionality in patients with knee osteoarthritis (OA), a structured and comprehensive rehabilitation program was implemented. This program emphasized strengthening exercises targeting both the quadriceps and hip muscles, as these are particularly beneficial for individuals with OA. It included hip joint strengthening, core stability, and lumbar/pelvic motor control exercises to improve muscle strength and stability, thereby enhancing knee joint function. Participants performed hip-strengthening exercises such as hip abduction and adduction, beginning without resistance and gradually progressing to 0.5 to 3 kg as their strength improved. Quadriceps-focused exercises were integrated to further support knee stability. Additionally, trunk stabilization movements, including crunches, bracing, and bridges, were employed to promote pelvic control and enhance trunk stability, alongside other dynamic stabilization exercises. Additionally, a hot pack device and a transcutaneous electrical nerve stimulation (TENS) device were used in treatment. Lumbopelvic motor control exercises aim to enhance lower body mobility and stability through progressive intensity as shown in Figs. 1– 5.

Fig. 1. Shown transcutaneous electrical nerve stimulation useful in physical therapy

Fig. 2. First session: basic exercises including hip abduction/adduction without resistance, and core stability exercises (hollowing, bracing) for joint stability

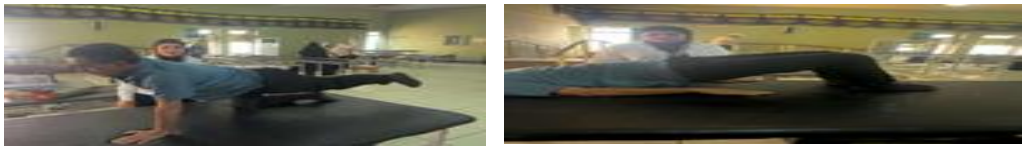

Fig. 3. Second sessions: added resistance (0.5–1 kg) for hip exercises; introduced additional core exercises (bridge, pug) to challenge muscles and maintain stability

Fig. 4. Third sessions: increased resistance (1–2 kg) for hip exercises; added lumbar stability exercises (balance, back extension); increased core exercise repetitions to 15 for endurance

Fig. 5. Fourth sessions: further increased resistance (2–3 kg) for hip exercises; added new core and hip strengthening exercises (resistance band curl, bridge with leg extension); increased repetitions to 20, with weight cuffs to reduce knee strain

2.4. Outcomes

The main study outcomes included the Western Ontario and McMaster Universities Osteoarthritis Index, modified for use in Spanish, which was used to assess three key aspects affected by knee impingement syndrome: pain, stiffness, and physical function. Pain was measured with five questions, with scores ranging from 0 (no pain) to 20 (severe pain). Stiffness was assessed with two questions, with scores ranging from 0 to 8, and physical function was assessed with 13 questions, with scores ranging from 0 to 68, this score for Osteoarthritis of the knee. The total score ranges from 0 (no symptoms) to 96 (severe symptoms) [19], and this score serves as both primary and secondary outcomes.

2.5. Sample size

Using Shahnawaz A.'s paper [20], the sample size was determined using the following formula for the primary outcome of pain:

$$n = 7.78 + \left(\frac{S.D}{Change\ in\ mean}\right)^2$$

To guarantee a representative sample of people with moderate to severe osteoporosis, the study enrolled 20 patients with grade II and III diagnoses.

2.6. Data collection

The outcome measurements, which comprised symptom severity as determined by the WOMAC (pain, stiffness, physical function) index, contained demographic information for each participant, such as name, age, sex, weight, and height. These metrics made it possible to compare clinical and functional results before and after the intervention in detail and evaluate how treatment effectiveness and demographic factors relate to one another. The same variables were used as secondary measures after the intervention.

2.7. Statistical analysis

SPSS version 24 was utilized for the analysis of the data. To describe the data, descriptive statistics were computed, including means, standard deviations, frequencies, and percentages. The data distribution's normality was assessed using the Kolmogorov-Smirnov test. The associations between demographic factors and results were also evaluated using one-way analysis of variance and Pearson's correlation coefficient.

3. Results

Data from a clinical investigation on anabolic steroid users were examined to look into the consequences of steroid abuse. Table 1 provides specifics on the study group's demographics. Twenty people participated in the study, with a 50% male (n=10) and 50% female (n=10) gender distribution. Diverse viewpoints were guaranteed within the sample due to the balanced gender representation. The participants' ages averaged 55.95 years, with a standard deviation of 6.68 years, indicating moderate age variability within the group, regarding body mass index (BMI), the average was 88.2, with a standard deviation of 5.28, reflecting a relatively homogenous distribution in terms of body composition among the participants, furthermore, the participants' physical measurements revealed that their mean weight was 69.00 kg, with a standard deviation of 7.814 kg, while the average height was 168.70 cm, with a standard deviation of 9.995 cm. These statistics indicate some variability in the height and weight of the study sample, which could contribute to a broader understanding of the study findings.

Table 1. Explain the demographic characteristic of the study sample

		Group n=20	
		Frequency	Percent (%)
Gender	Male	10	50%
	Female	10	50%
	Total	20	100%
Age	Mean	55.95	
	Std. Deviation	6.677	
BMI	Mean	88.2	
	Std. Deviation	5.28	
Height and weight		Weight	Height
	Mean	69.00	168.70
	Std. Deviation	7.814	9.995

The results in (Table 2) refer to the relationships between demographic variables and changes in medical outcomes (pre- vs. post-intervention) as assessed using Pearson Correlation. Notable findings include significant negative correlations between age and pain reduction ($r = -0.455$, $p = 0.044$), as well as between BMI and pain reduction ($r = -0.508$, $p = 0.022$). These results suggest that older participants and those with higher BMI experienced less reduction in pain after the intervention, similarly, a significant negative correlation was observed between age and functional improvement ($r = -0.495$, $p = 0.026$), indicating that older participants showed less functional improvement following the intervention. In contrast, other variables, including BMI, weight, and height, did not exhibit significant relationships with functional outcomes, in terms of stiffness, no significant correlations were found with any demographic variables. This lack of association suggests that changes in stiffness were not influenced by factors such as age, weight, height, or BMI.

Table 2. Relationship between demographic variable and medical outcomes difference between pre vs. post depend on Pearson Correlation

	Parameter	Person test	
		Pearson Correlation	P- value
Pain	Age	-0.455	0.044
	Weight (Kg)	0.142	0.551
	Length (Cm)	-0.260	0.268
	BMI	-0.508	0.022
Stiffness	Age	0.021	0.931
	Weight (Kg)	0.020	0.934
	Length (Cm)	0.277	0.237
	BMI	-0.009	0.971
Functional	Age	-0.495	0.026
	Weight (Kg)	-0.261	0.267
	Length (Cm)	-0.354	0.126
	BMI	-0.369	0.11

Table 3 summarizes the results of a one-way ANCOVA analyzing the relationship between gender and medical outcomes (pre- vs. post-intervention). The analysis indicates that there were no statistically significant differences in pain reduction ($F = 1.938$, $p = 0.181$), stiffness improvement ($F = 0.668$, $p = 0.425$), or functional outcomes ($F = 0.828$, $p = 0.375$) based on gender, these results suggest that the intervention's effectiveness in improving pain, stiffness, and functionality was not influenced by the participants' gender.

Table 3. The association between medical outcomes and gender One-way ANCOVA determines the difference between pre and post

Parameter	One-way ANCOVA	
	F-value	P- value
Pain	1.938	0.181
Stiffness	0.668	0.425
Functional	0.828	0.375

4. Discussion

The results of the study highlight how demographic characteristics have a significant influence on how well physical therapy works for individuals with osteoarthritis (KOA) of the knee. The significance of individual variables, especially age and body mass index (BMI), in

determining treatment results was emphasized, even though the intervention demonstrated notable improvements in important areas like pain reduction, improved functional capacity, and decreased stiffness. More research is required to completely understand the subtle effects of demographic factors in order to maximize therapeutic benefits, even if the documented improvements support physical as a viable non-invasive treatment for knee osteoarthritis. The was a strong negative correlation between age and improvements in pain and functional outcomes, suggesting that advantages of older people were less apparent than those of younger people. Given that older adults frequently have weaker muscles, more advanced joint deterioration, and longer recovery times, these findings are most likely the result of age-related physiological changes. The efficacy of physical therapy for older persons may be limited by degenerative changes in the knee joint, such as decreased synovial fluid production and cartilage degradation, slower cell repair rates, and decreased metabolic activity.

These findings are in line with previous studies that demonstrated that older patients getting physical therapy for KOA experienced worse therapeutic effects, including those by [22]. The role of age as a moderating factor in therapy outcome underscores the need for age-specific adjustments in rehabilitation protocols [23]. BMI was another significant factor influencing pain reduction; a higher BMI was negatively correlated with improved symptoms. This relationship can be attributed to the increased mechanical stress that excess body weight places on the knee joint, exacerbating pain and accelerating cartilage wear. Additionally, individuals with higher BMI are prone to heightened systemic inflammation due to increased production of pro-inflammatory cytokines, such as interleukin-6 (IL-6) and tumor necrosis factor-alpha (TNF-α), These inflammatory mediators contribute to chronic pain and joint stiffness, further hindering the effectiveness of physical therapy interventions [24]. Previous studies have corroborated these findings, emphasizing the dual burden of mechanical and inflammatory stressors in overweight and obese individuals with KOA [25].

Addressing BMI through weight management strategies may therefore enhance the therapeutic benefits of physical therapy, particularly in this patient population, interestingly, this study found no significant associations between gender and the measured therapeutic outcomes, including pain, stiffness, or functional improvements. This result suggests that physical therapy is broadly effective across genders, contrary to some prior research that has suggested gender-based differences in pain perception and muscle strength. Although these discrepancies might be the consequence of variations in study design or sample characteristics, the findings of this study indicate that physical treatment for KOA is universally applicable, irrespective of gender [26]. Similarly, there was no significant difference in pain or functional outcomes when height and weight were taken into account separately from BMI [27]. This supports the notion that a key determinant of medication success is BMI, which calculates body weight in relation to height [25]. Additionally, the study found no evidence of a significant relationship between improvements in stiffness and any of the demographic factors it examined.

The lack of association suggests that joint damage, the severity of the illness, or therapeutic compliance may have a greater impact on stiffness than demographic traits. It also implies that stiffness may respond uniformly to physical therapy, exhibiting consistent improvements across a variety of patient populations, regardless of individual characteristics [28]. These findings have significant therapeutic implications and emphasize the necessity for specialist methods to KOA management. For instance, tailored exercise regimens that take into consideration age-related related restrictions like decreased joint mobility and slowed recuperation may be beneficial for senior citizens. These modifications could involve low-impact exercises like seated strengthening or water therapy to improve muscular support and reduce joint stress. An integrated treatment approach that includes physical therapy [29-35], weight-management programs, nutritional counseling, and methods to reduce systemic inflammation may also be necessary for those with higher BNIs. Healthcare professionals can better address the individual requirements of their patients while simultaneously enhancing treatment outcome and quality of life by integrating demographic factors into rehabilitation programs. Future research ought to examine the mechanisms underlying these demographic correlations and suggest novel approaches to tailor rehabilitation to a variety of patient demographics. Using inflammatory biomarkers and biomechanical evaluations to identify the best physical treatment for KOA. In conclusion, physical therapy is still crucial for treating KOA, but its efficacy can be greatly increased by customizing interventions to target demographic characteristics like age and body mass index, resulting in more efficient and customized patient care [36-37].

5. Conclusion

This research emphasizes the potential advantages of adding hip and trunk stabilization exercises to knee osteoarthritis treatment, both groups showed positive changes, however, experimental group, which practiced the extra exercises, experienced more notable relief in pain and movement limitations, particularly in knee flexion and extension, based on WOMAC and VAS assessments. The outcomes indicate that these specific exercises help preserve muscle strength and enhance joint stability, leading to better overall functional results for the patients. This underscores how personalized exercise routines can play a critical role in managing knee osteoarthritis effectively.

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Nomenclature & Symbols

KOA	Knee Osteoarthritis	OA	Osteoarthritis
ACR	American College of Rheumatology	KL	Kellgren-Lawrence
BMI	Body Mass Index	SD	Standard Deviation
OA	osteoarthritis	TENS	Transcutaneous Electrical Nerve Stimulation device

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